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SYNCRUDE CANADA LIMITED
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TAILING PONDS RECLAMATION STUDY
PLANT 51

PROJECT NO. 9776

Syncrude Canada Ltd.
9915 - 108 Street,
Edmonton, Alberta. T5K 2G8

Syncrude

April 1974

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SECTION I

INTRODUCTION

A tailings retention pond forms an integral part of a hot water extraction plant. Its size is predicated, primarily, on three factors:

1) The design capacity of the synthetic crude complex.

2) On the amount of sand and sludge that must be contained prior to the earliest time that extraction tailings can be returned to the mined-out area.

3) The extraction plant requirements for clarification of recycle water.

Syncrude proposed using a sludge and sand retention pond in its initial application to the Alberta Oil and Gas Conservation Board for permission to build a commercial tar sand plant. Use of the retention pond was described in more detail in amending application dated May 3, 1968, as amended March 24, 1969 and August 7, 1971.

Syncrude intends to impound tailings in a retention pond of approximately 11.2 sq. miles. Its location, north of the plant, was selected on the basis of proximity to plant and mine site and the adverse waste to feed ratios that underlie the proposed pond area.

The Energy Resources Conservation Board approved Syncrude's application to construct a synthetic crude complex, however, under Board Approval No. 1920, approval was granted subject to certain further conditions and orders. Board Order No. 3, the subject matter of this study, expresses the concerns of the Energy Resources Conservation Board for the potential impairment to ultimate recovery of the oil sands that underlie the proposed location of the tailings retention pond. The referenced Order states:

"3. Prior to the commencement of major construction of the project facilities, Syncrude shall

> *(a) satisfy the Board that it would be economically feasible to remove and satisfactorily dispose of the tailings and overburden from the initial tailings disposal area described in the application referred to in Clause 1, Subclause (1), paragraph (a), in order that satisfactory recovery of the oil sands reserves of the area would ultimately be possible,*
>
> *or*

....2

(b) propose alternative or modified initial tailings disposal arrangements satisfactory to the Board such that the impairment of recovery of oil sands reserves would be minimized."

In the interest of providing the Board with a satisfactory response to the subject Order, Syncrude commissioned Canadian Bechtel Limited to develop a technically feasible method of removing and disposing into the mined-out area the tailings and sludge that will be placed into the retention pond over the 25-year life of the mine. Prior to defining the general criteria and assumptions for Bechtel, it was necessary to seek from the Board some clarification of Order No. 3; specifically, Syncrude sought clarification and elaboration of the term "economically feasible".

To this end, Mr. Nolan Blades of the Energy Resources Conservation Board offered the following comments:

1) The reclamation method must be technically feasible and preferably based on known technology and industry practise.

2) An order-of-magnitude capital and operating cost estimate for the reclamation concept would meet the "economic" aspects of the term.

3) The Board would not accept as satisfactory compliance with the Order a tar sands recovery concept based on an insitu method.

The guidelines provided by Mr. Blades were used to develop the scope of the study.

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SECTION 2

SCOPE

The scope of this study includes an order-of-magnitude capital and operating cost estimate to carry out the following tasks:

1. Remove all material placed in the retention pond during the life of the mine except approximately 5% of the coarse sand tailings which would remain in natural topographic lows such as the Beaver Creek channel (this would give the surface a planned effect which would be of benefit to a subsequent mining operation). The material that will be removed includes all non-indigenous borrow material used in the construction of starter dikes, coarse sand from the first 6 years of plant operation, all extraction and froth treatment sludge and effluent produced during the 25 years of operating the tar sand complex.

2. Redeposit all material removed from the retention pond into suitably constructed cells located in the mined-out area.

3. Protect the upper sufaces of the retention cells against erosion by wave action and vegetate their outer surfaces.

General Criteria and Assumptions

1. Contents of Main Tailing Pond at the end of 25 years, including dikes.

	Short Tons x 10^6	Cubic Yards x 10^6
Course Tailings (dry basis)	308	140
Contained water	87	103
Total @ 78% solids by weight	395	243
Sludge (dry basis)	120	54
Contained Water	280	332
Total @ 30% solids by weight	400	386
Recyclable water	117	139
Totals in main tailing pond (average 47% solids by weight)	912	768

....2

2. Contents of froth treatment tailing pond at end of 25 years.

	Short Tons x 10^6	Cubic Yards x 10^6
Dikes (from borrow)	7	5
Sludge (dry basis)	33	15
Contained water	51	60
Total @ 39% solids by weight	84	75
Recyclable water	2	2
Total (excluding dikes) (average 28% solids by weight)	86	77

3. Total material to be returned (excluding any possible makeup water) — 850 x 10^6 cyds.

4. Volume available within cells 3A and 3B up to natural grade. — 520 x 10^6 cyds.

5. Height of dike necessary to impound all material to be emplaced, leaving a minimum 10 foot freeboard. — approximately 60 ft.

6. Assume stable conditions: That is, no change in mass due to evaporation, precipitation or seepage, during the course of reclamation.

7. Makeup water, if required, to be drawn from Mildred Lake, which in turn is fed from the Athabasca River.

8. No effluent may be discharged to any water course.

9. Any water recirculated from the mining area, for water balance purposes, assumed to contain 10% solids by weight.

10. It is assumed that there will be no additional swell when material is moved from the tailing ponds to the mined out area.

....3

11. It is assumed that any contained valuable minerals in the froth treatment tailings will have been removed prior to or during pumping.

12. Replanting as per Site Reclamation Study dated September, 1973.

13. Dikes will be built by a cell method.

14. Use of repair facilities and general infrastructure is assumed.

15. No pumps, pipes or mobile equipment will be made available from the mining operation.

16. It is assumed that the project will be undertaken by Syncrude personnel and that all capital and operating costs will be at the direct level.

17. Capital and Operating Costs will be at a fourth quarter 1973 pricing level. Cash flow tables showing capital and operating costs for each year will be shown, all in 1973 dollars.

18. Consideration will be given to removing tailing at various rates. This will involve varying the number of dredges, together with associated pipes and pumps, in use at any one time.

19. It is assumed that removal of the tailings from the pond will commence 25 years after plant start-up, when mining has moved elsewhere.

SECTION 3

SUMMARY

The base scheme developed for removal of sand and sludge from the tailings retention pond consists of 5 suction dredges operated 8 months a year for a period of 10 years. Over the 10-year period a total of 933×10^6 cu. yds. of material will be handled at an average annual operating cost of $19,770,000 or $0.43 per ton of solids pumped. Table 3-1 summarizes the capital and operating costs on a year-by-year basis.

At a discount rate of 15% the present value of capital and operating costs for removing the tailings is $170,505,000. There are indications that the present value costs of removing the tailings with two dredges over a period of 22 years would be about $100,000,000.

Section 8 assesses the effects on costs of varying the rate of tailings removal. As expected the present value of costs tends to decrease as the number of dredges is decreased and the removal period is extended. Figure 8-1 shows that the 5 dredge case selected for study is on a relatively steep part of the curve.

The base scheme described, herein, represents one method of removing tailings from the retention pond. There has been no attempt at optimization of the scheme, nor has any consideration been given to use of recent advances in suction dredging such as the Marcona flow system which claims a capability of handling slurries containing over 50% solids by weight.

The environmental considerations attendant with removal of the tailings are discussed in Syncrude's report titled "Site Development and Reclamation Plan" (December 1973).

TABLE 3 - 1

SUMMARY OF CAPITAL & OPERATING COSTS

Thousands 1973 Dollars

Year	Initial Capital & Deferred Capital	Operating Cost	Total Annual Expenditure	PV @ 15% Discount Rate
0	64,347	-	64,347	64,347
1	-	18,923	18,923	16,455
2	7,216	18,923	26,139	19,764
3	241	19,164	19,405	12,759
4	1,630	19,164	20,794	11,890
5	940	19,164	20,104	9,996
6	123	19,164	19,287	8,338
7	265	19,164	19,429	7,303
8	2,305	19,164	21,469	7,018
9	-	21,201	21,201	6,027
10	-	21,201	21,201	5,241
11	-	6,360	6,360	1,367
			Total PV. of Costs @ 15%	170,505

SECTION 4

PROJECT DESCRIPTION

4.1 GENERAL

This study describes one way of removing tailing from the pond area to the mined out area. No attempt at optimization has been made. This study is limited to a currently feasible method; it highlights some of the major problems and outlines certain assumptions to calculate preliminary capital and operating costs.

The following major assumptions were made as a basis for the study.

- That it is possible to dredge the accumulated sand fraction from the upstream side of the dykes, without destroying the integrity of the dykes.

- That the dykes can be lowered as the water level is reduced.

- That all solids except 5% of the sand fraction can be slurried and pumped.

- That the Provincial Government will approve the use of hydraulic retention dams.

Tailing sand, sludge and water are slurried and pumped at 30% solids by weight, by means of suction dredges into Cells 3A and 3B, in the 25 year mined out area. Coarse sand is used to build retention dykes above natural grade by hydraulic methods. Excess sand, together with the sludge and water, is discharged into the cells. Water is recirculated into the tailing ponds to generate additional slurry.

A ten year project life was chosen upon which to base the capital and operating costs. The effect on costs of changing the project life is shown in Section 8. This project description is based on the equipment and pipe required for a ten year life.

The froth treatment pond sludge is removed first, since this pond

is at a higher elevation. Dredges Nos. 3 and 4 are used for this operation, which takes slightly less than two years. At the same time, Dredges Nos. 1 and 5 are used to remove the hydraulic sand portion of the dyke running between the main tailing pond and the froth treatment tailing pond. This must be removed early, and reduced to 1075 ft. elevation before the main tailing pond level is lowered. Dykes built from borrow are not dredged. Dredge No. 2, meanwhile, is working on the discharged sand in the deepest part of the main tailing pond.

Dredges Nos. 3 and 4 pump sludge directly into Cell 3A. Dredges Nos. 1 and 5 are used to build a section of the Cell 3A retention dykes. Dredge No. 2 pumps to Cell 3B and starts to build a section of retention dyke. A schematic drawing of this phase of the operations is shown in Sketch No. 51R-SK-S-768.

After completion of the above phase all five dredges are moved to the main tailing pond where they work around the pond perimeter. As the water level is lowered, they work gradually towards the center of the pond. Dredges 1 and 5 continue pumping to Cell 3A and building its retention dykes. Dredges 2, 3 and 4 pump to Cell 3B, building dykes and discharging into the pit. See Sketch No. 51R-SK-S-769.

The dredging operation is completed in the eleventh year and the Beaver Creek dam, in the tailing pond area, is breached to allow the creek to flow in its old bed. See Sketch No. 51R-SK-S-770.

4.2 DREDGING

The Ellicott series 3000 suction dredge is used for the slurrying and initial pumping operation. Five dredges are required to complete the project in 10.3 years. Each dredge pumps an average of 1000 cubic yards of solids per operating hour, at 30% solids by weight. Dredging proceeds continuously during the months of May to December inclusive. During the remaining four months, operations are reduced to care and maintenance because freezing is assumed to impede the operation.

As the water level is reduced, sand above that level is pushed towards the dredges by bulldozers. A hydraulic giant mounted on the front of each dredge is used to slurry the piles of sand, produced by the bulldozers, and bring it within reach of the dredge suction head.

The series 3000 dredge can pump at a rate of 1000 cubic yards of solids per hour up to a distance of 5000 ft. Each dredge is equipped with 5000 ft. of pipe in 20 foot lengths. Each length of pipe has a flexible steel coupling and is buoyed up by floats. The dredge personnel are able to add and remove pipe, but considerable snaking of the line is possible while the dredge moves backwards and forwards over a 10,000 foot face.

The dredges maneuver by means of their spuds and the use of head lines to the shore. In addition, work boats and launches are supplied to service the dredges, the pipelines, and to help move the dredges as required.

4.3 TAILING PIPES

Twenty-six inch diameter carbon steel all welded pipe is used to transport the slurry to the mined out area. Wall thickness is 0.344 inches and estimated life is 14,000 hours.

The use of rubber lined pipes or polyethylene pipe should be considered, such as Sclairpipe, by Dupont. Experience with this plastic pipe to date, is favorable and its use could offer considerable savings.

An average of 134,000 feet of pipe is in use during the froth treatment pond removal phase. During removal of the main pond tailing, this increases to 152,000 feet. Crews are provided to install new pipe, turn one-third of that in use every year and replace one-third each year. Pipe maintenance is carried out on a continuous basis throughout the year. Before initial startup, crews work on a three shift per day basis installing new pipe. During the froth treatment phase, crews are reduced to two shifts per day and finally during the main pond phase, they are reduced to a one shift operation.

Support equipment required under this heading includes:

Side boom tractors
Mobile cranes
Pipe trucks
Mobile workshop units
D/8 dozers
Front-end loaders
Mobile lighting plants

4.4 TAILING BOOSTER PUMPS

This is the largest item of operating cost. At the peak, a total of 31 pump stations are in use, each with a pump powered by a 2500 horsepower motor, giving a total of 77,500 installed horsepower. This is in addition to the dredge mounted pumps. All pumps are powered by electric motors with the exception of floating pump stations which are diesel powered.

The 2500 horsepower pump was chosen for purposes of standardization. Each is designed to pump a distance of 5000 feet at a minimum flow rate of 14 feet per second.

Diesel powered, floating barge mounted, pump stations are used with Dredges Nos. 1 and 5 during the froth treatment phase. This is necessary since the dredge mounted pumps are not able to pump to the first shore mounted booster station over the entire span worked. These floating pump stations are abandoned when the dredges move to the main pond phase. They are used again with others during the latter stages of the project, when dredges are operating towards the center of the pond.

4.5 WATER RECIRCULATION AND MAKEUP

Water is recirculated from the mined out area to ensure sufficient water to provide a 30% slurry. Current investigations indicate that colloids in the sludge are very slow to settle out. For this reason, it is assumed that there will be 5% solids in the recirculated water. Makeup water is pumped from Mildred Lake as required in the latter stages of the project.

The makeup water system has one 300 horsepower pump, barge mounted, with 1000 feet of 16 inch diameter delivery pipe. Design rate is 6500 gpm.

Water recirculating pumps are barge mounted in the center of Cells 3A and 3B. Each barge is equipped with two 2250 horsepower, electrically driven pumps. The discharge line, in each case, is 26 inches in diameter with a 0.25 inch wall thickness. The line length is 15,000 feet in the case of Cell 3A and 13,000 feet for Cell 3B.

4.6 DYKE BUILDING

Dykes are built around Cells 3A and 3B to contain all the sand, sludge and water which must be pumped from the tailing ponds. Material balance calculations show that perimeter dykes built some 60 feet above natural grade will impound all pumped material and will permit a freeboard of between 6 and 10 feet. Experience indicates that water clarification is impractical over the short term and must thus be impounded.

Small starter dykes are built from local borrow, and the main dykes are built with hydraulic fill. The method used is basically the same as that in the June 1973 Appropriation Estimate, which in turn is in accordance with Dr. R.M. Hardy's recommendations, as presented in his report dated March 7, 1973.

Dykes are built at a consistent rate round the total perimeter to be impounded. Cells are raised in 5 to 6 foot lifts. Slurry discharge rate from the tailing pipes into the cells is dispersed by means of a "spoon" discharge, as described in Dr. Hardy's report. Fines and water are collected at the downstream end of the cell and discharged by means of a timber box spillway into the upstream side of the dam. Pipes into Cells 3A and 3B, carrying this overflow, are continued down the old dragline face into the pit. This will help reduce scouring of the old pit walls. As an additional precaution, the upstream toe of the sand dykes are placed at least 100 feet back from the pit rim, since some subsidence will be unavoidable.

Each lift, of all dykes, is rolled with vibratory rollers to effect maximum shell compaction.

The dykes so formed contain no hydraulic core or slurry trench, and although compacted, are not competent hydraulic structures. Tailing dykes built to retain tailing in the original tailing area are built in a similar manner. However, in the case of the tailing dykes, sand is discharged on the upstream side of the dyke to form an impounding structure, sloping down at between 3% and 5%. According to Dr Hardy, sludge will eventually fill the void spaces, creating a competent hydraulic structure.

When building retention dykes around Cells 3A and 3B, the discharged sand is not available to protect the main dam structure. (See Sketch 51E-SK-S-771). After building the dykes there is barely enough coarse sand remaining to reach natural grade, assuming a 4% slope on the sand/water contact. The upstream surface must be protected from the wave action.

Soil cement protection is used for the dual purpose of creating an impervious layer and to protect against wave action. Pre-mixed soil cement, containing 9% cement by volume, is laid down and compacted in 6 inch layers along the upstream face of the dam. The horizontal width of the layers is 11 feet and the thickness of the completed facing, normal to the slope of the embankment is 3 feet.

The entire upstream face of the dam is protected in this way down to below grade to protect from seepage below the dam. Gradually changing water levels necessitate total face protection.

A batch plant is provided to mix the cement, trucks to transport it, spreaders to spread it, vibrators to compact it, and D/9 dozers to build starter berms for the cell process.

A soil cement facing, as described above, will be expensive, but at this point, provides the most positive protection. Rip-rap is not available and, in addition, would not make the dam impervious. As water retained within the dykes is above the water table, it is possible that some will seep away in time, leaving the expensive soil cement monument performing no functions. However, this is deemed necessary for safety and will, at least, provide space for future tailing retention from other mining areas.

4.7 MISCELLANEOUS

This item includes:

Electrical Distribution
Revegetation
Road Building and Maintenance

4.7.1 Electric Distribution

Overhead lines at 15 kV are run from a main central substation along the pipelines. One hundred thirty-thousand feet of overhead lines are required for the froth treatment pond phase, with an additional 38,000 feet required for the main pond phase. A step-down transformer to 5.6 kV is installed at each pump station. Twenty-five transformers are required initially, and another 6 are purchased during year one for the main pond phase.

4.7.2 Revegetation

A total of 231 acres of exposed dyke face will eventually be available around Cells 3A and 3B, for revegetation. An annual allowance is made to facilitate this operation.

4.7.3 Road Building and Maintenance

The following equipment is included in the road maintenance fleet:

D/7 bulldozer
Motor grader
Backhoe
Front end loader
10T trucks
Compactor

SECTION 5

INITIAL CAPITAL COST SUMMARY

Prior to the start of tailing removal from the main pond area and its disposal in the mined out area, a sum of the order of magnitude of $64,347,000 must be expended. These expenditures cover the cost of equipment, materials, power service, operating supplies and labor utilized in the installation and erection of the various facilities required to begin full production in year one.

Estimated costs were obtained from discussion with various manufacturers and suppliers; from experience obtained in previous projects of similar nature; and by direct estimation where required.

Installation labor costs include estimation for work to be done on contract, and those estimated by Syncrude for work to be done by their personnel.

Equipment and material costs include the purchase price with estimated freight to the site, but do not include federal or local taxes, interest, insurance, or import duties if required.

All costs are based upon those in effect at the end of 1973.

Capital cost expenditures for the various years are as follows:

	$ (1000)
Item I	
Major equipment and materials supplied and/or erected under Subcontract.	29,262
Item II	
Major equipment and materials delivered for erection by Syncrude personnel.	20,260
Item III	
Labor costs to Syncrude for erecting and installing Item II and constructing roads, etc.	1,407

	$ (1000)
Item IV	
Supply costs to Syncrude for erecting and installing Item II and constructing roads, etc.	548
Total	51,477
Contingency @ 15%	7,722
Engineering @ 10%	5,148
Grand Total	64,347

For details see Appendix B.

Note: Although many of the major items of equipment and services have considerable useful life remaining at the end of the project, no attempt has been made in this report to take into account a salvage or transfer value.

SECTION 6

DEFERRED CAPITAL COST STUDY

Prior to the completion of tailing removal from the froth treatment pond (scheduled to last for two years), and the beginning of tailing removal from the main pond area, a further capital expenditure must be made for installation of additional pipelines and service. This work is scheduled for the beginning of year two.

The following years show the capital required for replacement of equipment, and the addition of new equipment when required in year eight. Cost estimates as used for capital expenditures and shown in Section 5 are used here.

Year	Expenditures $ (1000)
2	7,216
3	241
4	1,623
5	940
6	123
7	265
8	2,305
9	-
10	-
Total	12,713

Note: Although much equipment remains at the end of the project, with varying degrees of usable life remaining, no attempt has been made in this report to take into account a salvage or transfer value.

SECTION 7

OPERATING COST SUMMARIES

7.1 OPERATING COSTS

Operating costs are calculated in terms of fourth quarter, 1973, prices. Details of the estimate can be found in the appendix and summaries are attached. Cost breakdowns are as follows:

7.1.1 Supervision

This includes direct supervision only and does not include any provision for senior management, engineering or planning. All staff are maintained on a 12 month per year basis.

7.1.2 Operating Labor

An average cost of $7.75 per manhour is used for all operating labor. This is deemed to include all normal fringes and payroll additives. Skilled personnel and those necessary for care and maintenance operations during the winter months of shutdown are employed on a permanent 12 month per year basis. Non-essential positions are vacant during the shutdown period. These positions are manned for 8 months per year only.

7.1.3 Maintenance Labor

This is taken as 67% of maintenance supplies. The number of men required is derived using the $7.75 per hour (same as for Operating Labor) figure, or $15,460 per year per man, on a 12 month per year basis.

7.1.4 Operating Supplies

Standard estimating techniques were used; details can be found in Appendix C. Key unit prices used are:

Power	-	$0.007 per KWH
Diesel	-	$0.24 per I Gal.
Gasoline	-	$0.45 per I Gal.

The above supplies have been individually broken out in the summaries, so that different prices may be used as desired.

7.1.5 Maintenance Supplies

Again, standard estimating techniques were used and details can be found in the Appendix.

7.2 OPERATING COST FUNCTIONS

Operating costs are further broken down by function. A description of these functions can be found in Section 4.

TABLE 7 - 1

SYNCRUDE CANADA LTD.
BECHTEL JOB NO. 9776
TAILING PONDS RECLAMATION
ANNUAL OPERATING COST SUMMARY BY FUNCTION

YEARS 1 & 2

	Function	Super-Vision	Oper-ating Labor	Maint. Labor	Operating Supplies	Maint. Supplies	Total	Tons Of Solid (1000)	$/Ton of Solids	Diesel I. Gals (1000)	Gasoline I. Gals (1000)	Power MWH	Labor No. Personnel 12 Mo/Year	Supervision No.	Labor No. Personnel 8 Mo/Year
		$ (1000)													
1.	Dredging	222	2208	1008	1181	1511	6130		0.13	2392	-	-	157	11	76
2.	Tailing Pipes	70	910	105	1012	157	2254		0.05	250	-	-	66	4	-
3.	Tailing Booster Pumps	173	281	2223	1473	3333	7483		0.16	1022	73	163510	148	9	21
4.	Water Recirculation & Makeup	6	43	51	197	77	374		0.01	-	10	26981	3	-	4
5.	Dyke Building	70	635	385	522	578	2190		0.05	840	-	-	25	4	62
6.	Miscellaneous & Revegitation	19	216	63	100	94	492		0.01	83	40	-	18	1	-
	Total Operating Cost/Year	560	4293	3835	4485	5750	18923	45652	0.41	4587	123	190501	417	29	163

TABLE 7 - 2

SYNCRUDE CANADA LTD.
BECHTEL JOB NO. 9776
TAILING PONDS RECLAMATION
ANNUAL OPERATING COST SUMMARY BY FUNCTION

YEARS 3 - 8

	Function	Supervision	Operating Labor	Maint. Labor	Operating Supplies	Maint. Supplies	Total	Tons Of Solid (1000)	$/Ton of Solids	Diesel I. Gals (1000)	Gasoline I. Gals (1000)	Power MWH	Labor No. Personnel 12 Mo/Year	Supervision No.	Labor No. Personnel 8 Mo/Year
		$ (1000)													
1.	Dredging	222	2208	1008	1181	1511	6130		0.13	2392	-	-	157	11	76
2.	Tailing Pipes	70	455	53	1015	79	1672		0.04	125	-	-	33	4	-
3.	Tailing Booster Pumps	173	281	2251	1477	3824	8306		0.18	-	73	202765	169	9	21
4.	Water Recirculation & Makeup	6	43	51	197	77	374		0.01	-	10	26981	3	-	4
5.	Dyke Building	70	635	385	522	578	2190		0.05	840	-	-	25	4	62
6.	Miscellaneous & Revegitation	19	216	63	100	94	492		0.01	83	40	-	18	1	-
	Total Operating Cost/Year	560	3838	4111	4492	6163	19164	45652	0.42	3440	123	229746	405	29	163

TABLE 7 - 3

SYNCRUDE CANADA LTD.
BECHTEL JOB No. 9776
TAILING PONDS RECLAMATION
ANNUAL OPERATING COST SUMMARY BY FUNCTION

YEARS 9 - 11

Function	Super-vision	Oper-ating Labor	Maint. Labor	Operating Supplies	Maint. Supplies	Total	Tons Of Solid (1000)	$/Ton of Solids	Diesel I. Gals (1000)	Gasoline I. Gals (1000)	Power MWH	Labor No. Personnel 12 Mo/Year	Supervision No.	Labor No. Personnel 8 Mo/Year
	$ (1000)													
1. Dredging	222	2208	1008	1181	1511	6130		0.13	2392	-	-	157	11	76
2. Tailing Pipes	70	455	53	1015	79	1672		0.04	125	-	-	33	4	-
3. Tailing Booster Pumps	173	281	3042	2287	4560	10343		0.22	3066	73	202765	201	9	21
4. Water Recirculation & Makeup	6	43	51	197	77	374		0.01	-	10	26981	3	-	4
5. Dyke Building	70	635	385	522	578	2190		0.05	840	-	-	25	4	62
6. Miscellaneous & Revegitation	19	216	63	100	94	492		0.01	83	40	-	18	1	-
Total Operating Cost/Year	560	3838	4602	5302	6899	21201	45652	0.46	6506	123	229746	437	29	163

SECTION 8

THE EFFECT OF CHANGES IN PROJECT LIFE ON COSTS

This section approaches the problem of assessing the effect on costs as project life is varied.

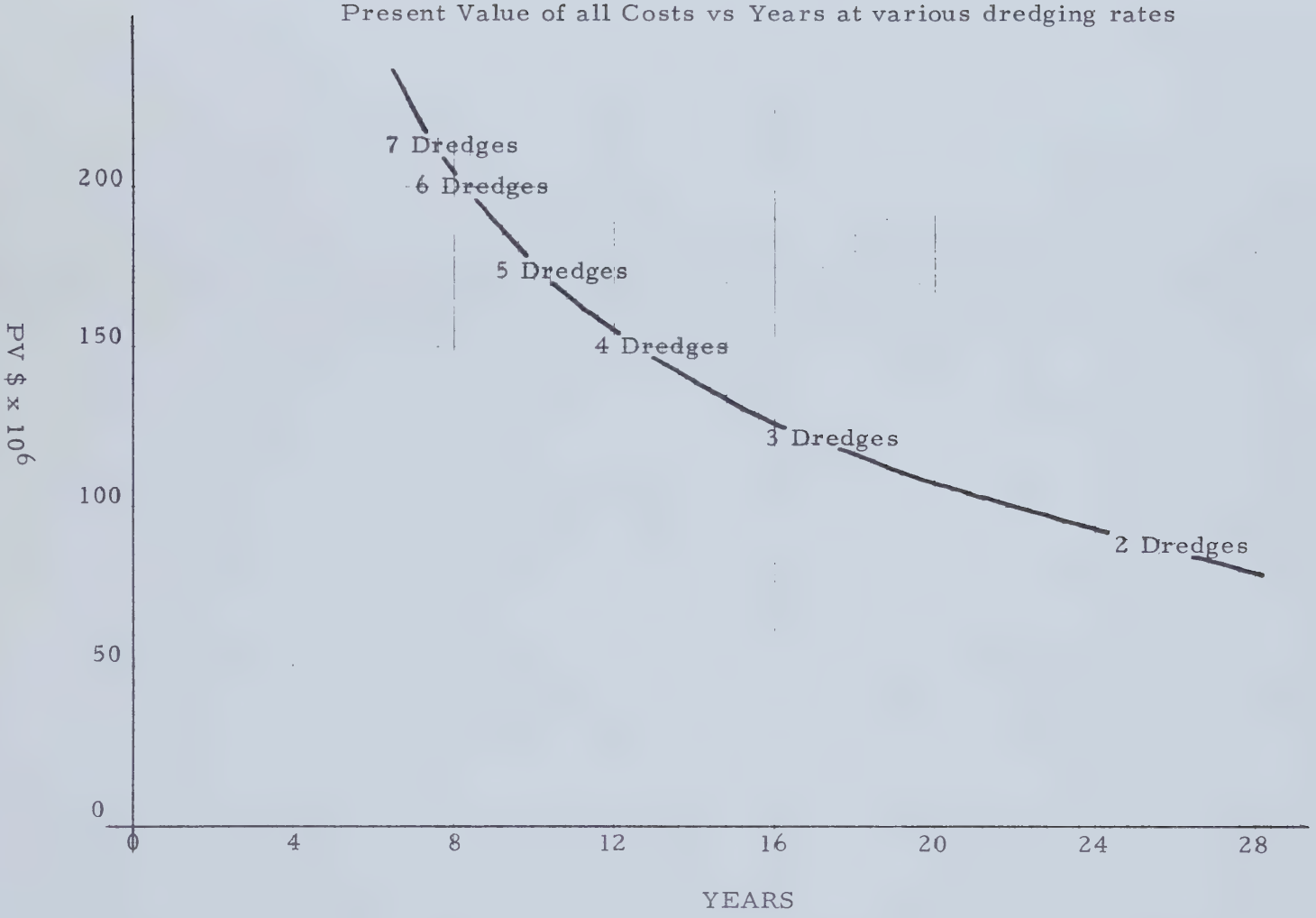
Certain costs, both capital and operating, are constant. Others, vary directly with the number of dredges. To create the curve shown in Figure 8-1, an attempt was made to separate these costs. The number of dredges was varied, the costs were then recombined and a present value at a 15% discount rate calculated. Project life can easily be calculated for different numbers of dredges.

Figure 8-1 is a plot of present value versus years of project life of from 2 to 7 dredges.

The time value of money emphasizes the cost saving effect of increasing project life. However, reduced capital expenditure from a smaller equipment spread, coupled with the long working life of a dredge, contribute to reducing overall present value of costs as project life is extended. Again, the effect is magnified by the fact that no salvage value is taken for the schemes using more dredges on shorter project lives.

In conclusion, it should be stressed that all points projected on the curve are subject to considerable uncertainty. Nevertheless, the present value of costs should be reduced by extending the project life. Moving down the curve from the steepest section, it is possible to see that a project life of around 22 years would have an expected present value cost of around $100 million.

FIGURE 8 - 1


Present Value of all Costs vs Years at various dredging rates
7 Dredges
6 Dredges
5 Dredges
4 Dredges
3 Dredges
2 Dredges
PV $ x 10^6
200
150
100
50
0
0
4
8
12
16
20
24
28
YEARS

SECTION 9

APPENDIXES

APPENDIX A

DESIGN CRITERIA

A.1 GENERAL CRITERIA AND ASSUMPTIONS

Except where specifically noted, general criteria used for the Appropriation Estimate holds for this study. In addition, further assumptions are:

- Eight months dredging and dyke building campaign. Operations shut down for the months of January through April.
- Average pumped slurry contains 30% solids by weight.
- Evaporation, seepage and precipitation affects upon materials balance is excluded.
- All water must be contained; no discharge into the watershed permitted.
- Makeup water taken from Mildred Lake.
- Recirculated water from Cells 3A and 3B is assumed to contain 5% solids (by weight) of suspended colloids.

A.2 MATERIALS BALANCE

A.2.1 Summary

	Short Tons 10^6	Cubic Yards 10^6
Dry solids to be pumped	446	200
Contained and Recyclable water	533	632
Recirculated water	508	602
Dry solids in recirculated water	25	11
Fresh water to pump recirculated solids	85	101
Total to be pumped	1597	1546
Less recirculated water and solids	533	613
Total to be contained within mined out area	1064	933
Dry solids left by dredge	15	9
Contained water	4	3
Total left within tailing ponds in addition to starter dikes from local borrow.	19	12

A.2.2 Contents of main tailing pond at the end of 25 years, including sand dikes but excluding starter dikes built from local borrow.

	Short Tons 10^6	Cubic Yards 10^6
Coarse tailing (dry basis)	308	140
Contained water	87	103
Total @ 78% solids by weight	395	243
Sludge (dry basis)	120	54
Contained water	280	332
Total @ 30% solids by weight	400	386
Recyclable water	117	139
Totals in main tailing pond (average 47% solids by weight)	912	768

A.2.3 Contents of Froth Treatment Tailing Pond at end of 25 years, excluding dikes built from local borrow.

	Short Tons 10^6	Cubic Yards 10^6
Sludge (dry basis)	33	15
Contained water	51	60
Total @ 39% solids by weight		

A.2.4 Quantity of material to be dredged and pumped from the main tailing area:

- Includes recirculated water to assure a pumpable slurry containing an average of 30% solids by weight.
- Excludes 5% of the coarse sand fraction at 78% solids by weight.

	Short Tons 10^6	Cubic Yards 10^6
Sand (dry basis)	293	131
Contained water	83	99
Sludge (dry basis)	120	54
Contained water	280	332
Recyclable water	117	139
Recirculated water	484	574
Total	1377	1329

A.2.5 Quantity of material to be dredged and pumped from the Froth Treatment Tailing Pond.

- Includes recirculated water to reduce slurry to 30% solids by weight.

	Short Tons 10^6	Cubic Yards 10^6
Sludge (dry basis)	33	15
Contained water	51	60
Recyclable water	2	2
Recirculated water	14	28
Total	110	105

A.2.6 Recirculated water, contained solids and makeup water.

Total recirculated water is the summation of that required in A.2.4 and A.2.5, or 508 x 10^6 tons.

Assume that the recirculated water is accompanied by 5% colloidal solids by weight. Thus total solids recirculated = $508 \times 0.05 = 254 \times 10^6$ tons. This sludge requires a further 85×10^6 tons of water to create a pumpable slurry at 30% solids.

Assume that this 85×10^6 tons of makeup water is taken from Mildred Lake and thus must be contained within the mined out area.

A.3 PRODUCTION BASIS

A.3.1 Hours per Year

Working months per year	8
Operating hours per day	24
Operating hours per year	$\frac{365 \times 8 \times 24}{12}$
	$= 5840$
System availability	70%
Effective operating hours/year	4088

A.3.2 Production per Operating Hour

Production is based on multiples of the Ellicott Series 3000 suction dredge. Average production is taken as 1000 cubic yards of solids per operating hour. The base production rate used in this study uses 5 dredges producing 5000 cu. yds. of solids per hour.

A.3.3 Hourly Unit Production Rates

Cubic yards of solids per hour	= 1000
Tons of solids per hour $\frac{1000 \times 27 \times 62.4 \times 2.65}{2000}$	= 2232
Tons of slurry per hour (@ 30% solids)	= 7440
Gallons of slurry per minute	=24000

A.3.4 Recirculated Water

Total recirculated water & solids = 533×10^6 Tons

or $\frac{533 \times 10^6 \times 2000}{8.345}$ = 1.277×10^{11} Gals.

Assume 90% availability on recirculated water system. Effective hours per year = $5840 \times 0.9 = 5256$

Gals. of slurry/min. = $\frac{1.277 \times 10^{11}}{5256 \times 10.3 \times 60}$

= 39300 gals/min.

Say 40,000 gals/min. for design purposes.

A.3.5 Makeup water from Mildred Lake.

$$\frac{85 \times 10^6 \times 2000}{8.345} = 2.037 \times 10^{10} \text{gals}$$

With 90% availability

$$\text{Gals/min} = \frac{2.037 \times 10}{5256 \times 10.3 \times 60} = 6271$$

Say 6500 gals/min for design purposes.

A.3.6 Annual Unit Production Rates

Cubic yards of solids:	1000 x 4088	4.09×10^6
Cubic yards of slurry:	3333 x 4088	13.63×10^6

A.4 PRODUCTION SCHEDULE

	Froth Treatment Pond		Main Tailing Pond	
Year	Production	Cumulative	Production	Cumulative
1	8.2	8.2	12.3	12.3
2	6.8	15.0	13.6	25.9
3	Complete after 1.8 years		20.5	46.4
4	Dredges moved to main tailing pond.		20.5	66.8
5			20.5	87.3
6			20.5	107.7
7			20.5	128.2
8			20.5	148.6
9			20.5	169.1
10			20.5	189.6
11			6.4	196.0
			Complete after 10.3 years.	

NOTE: Units are millions of cubic yards of solids.

A.5 VOLUMETRIC BALANCE

Total material to be placed within the mined out area is 933×10^6 cu. yds. This volume will be contained within cells 3A and 3B as follows:

	Cubic Yards 10^6
Within the cells to natural grade	596
*Compacted sand dikes	41
Contained within sand dikes above natural grade.	296
Total	933

*3:1 side slopes, 20' wide crest, 60' high & about 7' of freeboard.

APPENDIX B

INITIAL CAPITAL COST DETAIL

$ (1000)

Item I - Major Equipment and Materials Supplied and/or Erected Under Subcontract

Tailing pumps - electric driven	$18,750	
Tailing pumps - diesel driven	675	
Water pumps-electric driven	2,790	
Pumps - spares	360	
Barges - pumps - diesel	86	
Barges - pumps - water	70	
Barges - work	43	
Crew launch	20	
Power lines	529	
Sub stations	1,160	
Increased shops and offices	600	
Side boom tractors	410	
Mobile cranes	260	
Pipe trucks	71	
Dozers - D7	428	
Dozers - D8	198	
Dozers - D9	864	
Motor grader	81	
Backhoe	82	
Front end loaders	68	
Trucks - haul with spreaders	91	
Trucks - haul	31	
Trucks - pickup	43	
Low Boy	21	
Mobile lighting plants	32	
Mobile service shop	55	
Compactors	700	
Cement compactors	300	
Batch plant	125	
Mobile - equipment spares	319	$29,262

Item II - Major Equipment and Materials Delivered for Erection by Syncrude Personnel

Dredges	$7,193	
Dredge pipe	550	
Balljoint connectors	3,977	
Floats	4,826	
Tailing pipe	2,640	
Water pipe	580	
Dredge spares	360	
Cement	134	$20,260

Item III - Labor Costs to Syncrude for Erecting and Installing Item II and Constructing Roads, etc.

Tailing pipe	$1,039	
Water pipe	218	
Dredges-pipes-floats-connectors	100	
Road construction	50	$ 1,407

Item IV - Supply Costs to Syncrude for Erecting and Installing Item II and Construction Roads, etc.

Tailing Pipe	$ 418	
Water pipe	60	
Dredges	50	
Road construction	20	$ 548

APPENDIX C

Basis for Calculating Operating Costs

This section contains backup data supporting the summary sheets shown under the Operating Cost Summary Section, in the main body of the report.

Headings are broken out horizontally from the summary.

SUPERVISION

Average loaded cost for supervision is taken from the appropriation estimate, and is $19,640 per year.

	Positions	Shifts/day	Total
Dredge Superintendent	1	1	1
Dredge Foreman	1	1	1
Chief Electrician	1	1	1
Chief Mechanic	1	1	1
Pipeline Foreman	1	1	1
Dyke Building Foreman	1	1	1
Shift Bosses	2	2	8.4
Engineer	1	3	1
Surveyor	1	1	1
Surveyor's Helper	1	1	1
Clerical	2	2	2
Maintenance Foreman	1	1	1
Shift Bosses	2	3	8.4
			28.8

Annual Supervision cost - $28.8 \times \$19,460$
$= \$560 \times 10^3$

OPERATING LABOR

All labor is based on a gross rate, including burden, fringes and overtime, of $15,460 per year, or $7.75 per hour.

The rate is derived as follows:

Pay Grade	% Distribution	$ (1000)/year
3	10	1.85
4	60	9.58
5	30	4.03
		15.46

$$\text{Rate per hour} = \frac{15460}{2000} = \$7.75$$

NOTE: These labor rates are taken from the appropriation estimate.

Labor is based on either an 8 month or 12 month year, according to job requirement. Similarly, labor is supplied on a 1, 2, or 3 shifts per day basis; also dependant upon requirement. The swing shift factor used on shift work is 1.4, 2.8, and 4.2 respectively.

Manpower figures shown are those from year 3 on, needs for preproduction and the first 2 years of operation vary according to requirements.

1. Dredging

		Positions	Shifts/day	Total
Dozers	On board dredges (5)	5	3	21
Dredge Captain		5	3	21
Leverman		5	3	21
Mechanic		5	3	21
*Deck Hand		5	3	21
*Laborer		5	3	21
*Operator	Work boats (4)	4	2	11.2
*Laborer		8	2	22.4
Electrician		1	3	4.2
Instrumentation		1	3	4.2
	Total			168

*8 months/year. 75.6 men @ $15,460 $\times \frac{8}{12}$ = $\$779 \times 10^3$

12 months/year $\frac{92.4}{168.0}$ men @ $15,460 = $\$1,429 \times 10^3$

Total Operating Labor Cost for Dredging $\$2,208 \times 10^3$

Twelve month personnel go on to care and maintenance during winter period. Eight month personnel are rehired or recruited in the Spring.

2. Tailing Pipes

	Positions	Shifts/Day	Total
Welders 2)	6	1	8.4
Laborers 2) 3 pipe crews	6	1	8.4
Operators 1)	3	1	4.2
Truck drivers	2	1	2.8
Dozer Operators	2	1	2.8
F. E. L. operators	2	1	2.8
Total			29.4

Crews work throughout year, changing and turning pipes.

Operating labor costs of tail pipes = 29.4 x $15,460
= $455 x 10^3

During preproduction the above crews work on a 3 shift per day basis, for initial installation:

Thus labor cost is $455 x 10^3 x 3 = $1365 x 10^3

During years 1 and 2 the above crews work on a 2 shift per day basis installing new pipe for the move into the main tailing pond at the end of year 2:

Thus labor costs is $455 x 10^3 x 2 = $910 x 10^3

3. Tailing Booster Pumps

	Positions	Shifts/Day	Total
*Inspector	5	3	21
Electricians	2	1	2.8
Instrumentation	1	1	1.4
Total			25.2

*Eight month per year 21 men @ $15,460 x $\frac{8}{12}$ = $216 x 10^3

Twelve month per year 4.2 men @ $15,460 = 65 x 20^3

This item is constant after startup; not required during preproduction.

4. Water Recirculation & Makeup

*Eight months per year 4.2 men @ $15,460 x $\frac{8}{12}$ = $ 43 x 10^3

This item is constant after startup; not required during preproduction.

5. Dyke Building

	Positions	Shifts/Day	Total
*Compactor operations	5	3	21.0
*Dozer operators	5	3	21.0
*Cement truck operators	5	1	7.0
*Compactor operations	3	1	4.2
*Batch plant operators	2	1	2.8
*Laborers	4	1	5.6
Total			61.6

*Eight months/year 61.6 men @ $15,460 x $\frac{8}{12}$ = $\$635 \times 10^3$

This item is constant from year 1 on.

6. Miscellaneous & Revegetation

	Positions	Shifts/Day	Total
Dozer operator	1	1	1.4
Grader operator	1	1	1.4
Backhoe operator	1	1	1.4
One-half cyd F. E. L.	1	1	1.4
Truck operators	2	1	2.8
Compactor	1	1	1.4
Laborers	3	1	4.2
Total			14.0

Twelve month/year 14.0 men @ $15,460 = $\$216 \times 10^3$

This item is constant throughout project; 2 months in preproduction.

MAINTENANCE LABOR

Sixty-seven percent of maintenance supplies. Average cost/man year is $15,460.

Year	Maint. Supplies $ (1000)	Maint. Labor $ (1000)	Maint. Labor Personnel
1-2	5750	3835	248
3-8	6163	4111	266
9-11	6899	4602	298

OPERATING SUPPLIES

			$/Yr. (1000)	$/Yr (1000)
1.	Dredging			
	Dredges			
	Fuel 98 I gals/hr/dredge			
	98 x 4088 x 5 x 0.24			
	2003 x 10^3 x 0.24		481	
	Lube 10% of fuel		48	
			529	529
	Floating Dredge Pipe			
	Replace 1/3 of pipe each year.			
	0.33 x 5000' x $20 x 5		167	
	Replace 10% of couplings each year			
	0.1 x 250 x $3000 x 5		375	542
	Mobile Equipment			
	See mobile equipment schedule			88
	Work Boat & Launches			
	Fuel 10 I gals/hr/boat			
	10 x 2044 x 4 x 0.24			
	82 x 10^3 x 0.24		20	
	Lube 10% of fuel		2	
			22	22
		Total		1181
2.	Tailing Pipes			
	Years 1 & 2			
	Pipes			
	Replace 1/3 each year			
	44,500' x $20		890	
	Mobile Equipment (See Schedule)		122	
	Total years 1 & 2		1012	1012
	Years 3-11			
	Pipes			
	Replace 1/2 each year			
	47,700' x $20		954	
	Mobile Equipment (See Schedule)	1	61	
	Total years 3-10		1015	1015

3. Tailing Booster Pumps		$/Yr (1000)
Years 1 & 2	$/Yr. (1000)	
Electric pumps		
1600 kW x 25 x 4088 x 0.007		
163520 MWH x 0.007	1145	
Diesel pumps 125 I gals/pump/hr.		
Fuel 125 x 2 x 4088 x 0.24		
$1022 \times 10^3 \times 0.24$	245	
Lube 10% of fuel	25	
	270	
Mobile Equipment (See Schedule)	58	
Total Years 1 & 1	1473	1473
Years 3 - 8		
Electric pumps		
1600 kW x 31 x 4088 x 0.007		
202765 MWH x 0.007	1419	
Mobile Equipment (See Schedule)	58	
Total years 3 - 8	1477	1477
Years 9 - 11		
Electric pumps	1419	
Diesel pumps.		
Fuel 125 x 6 x 4088 x 0.24		
3066x 10 x 0.24	736	
Lube 10% of fuel	74	
	810	
Mobile Equipment (See Schedule)	58	
Total years 9-11	2287	2287
4. Water Recirculation & Makeup		
Pump #1		
200 kW x 1 x 4088 x 0.007		
818 MWH x 0.007	6	
Pumps #2 & 3		
1600 x 4 x 4088 x 0.007		
26163 MWH x 0.007	183	
Mobile Equipment (See Schedule)	8	
Total	197	197

		$/Year (1000)	$/Year (1000)
5.	Dyke Building		
	Mobile Equipment (See Schedule)	522	522
6.	Miscellaneous		
	Revegitation (allowance)	11	
	Electrical Distribution (1% of cost)	21	
	Mobile Equipment (See Schedule)	68	
	Total	100	100
	MAINTENANCE SUPPLIES		
1.	Dredging		
	Dredges		
	$60/dredge/hour (Manufacturer)		
	60 x 5 x 4088	1226	
	Mobile Equipment (See Schedule)	272	
	Work boats & Launches		
	$1.56/hour/boat		
	1.56 x 2044 x 4	13	
	Total	1511	1511
2.	Tailing Pipes		
	Years 1 & 2		
	Mobile Equipment (See Schedule)	157	157
	Years 3-11		
	Mobile Equipment (See Schedule)	79	79
3.	Tailing Booster Pumps		
	Years 1 & 2		
	Electric Pumps $30/hour/station		
	30 x 25 x 4088	3066	
	Diesel pumps $30/hour/station	245	
	30 x 2 x 4088		
	Mobile Equipment (See Schedule)	22	
	Total Years 1 & 2	3333	3333

		$/Year (1000)	$/Year (1000)
3.	Tailing Booster Pumps (continued)		
	Years 3-8		
	Electric Pumps		
	30 x 31 x 4088	3802	
	Mobile Equipment (See Schedule)	22	
	Total Years 3 - 8	3824	3824
	Years 9-11		
	Electric Pumps (see above)	3802	
	Diesel pumps		
	30 x 6 x 4088	736	
	Mobile equipment (See Schedule)	22	
	Total Years 9-11	4560	4560
4.	Water Recirculation & Makeup		
	Pumps $6/hour/station		
	6 x 3 x 4088		74
	Mobile Equipment (See Schedule)		3
	Total		77
5.	Dyke Building		
	Mobile Equipment (See Schedule)		578
6.	Miscellaneous		
	Electrical Distribution (2% of cost)		42
	Mobile Equipment (See Schedule)		52
	Total		94

ANNUAL MOBILE EQUIPMENT SUPPLY COSTS

ITEM	No. of Units	Machine Hrs./Year	Oper. Supplies (Incl. Fuel) $/Hr.	Oper. Supplies (Incl. Fuel) $/Yr. (1000)	Maint. Supplies $/Hr.	Maint. Supplies $/Yr. (1000)	Total Supply $/Yr. (1000)	Gals. of Fuel (1000)
DREDGING								
Dozers D/7 (8 month operation)	5	21,900	4.03	88	12.40	272	360	307
TAILING PIPES								
Side Boom Tractor	5	8,333	1.95	16	3.19	27	43	48
Mobile Crane	2	1,333	2.89	4	1.44	2	6	4
Pipe Truck	3	3,333	3.15	11	1.50	5	16	15
Mobile Workshop	4	3,333	3.15	11	1.50	5	16	15
Dozers D/8	2	3,333	3.37	11	10.20	33	44	30
F.E.L. 1/2 Cyd.	3	3,333	2.22	7	1.50	5	12	10
Mobile Lighting	4	1,333	0.60	1	0.50	1	2	3
(12 month operation) (1 shift/day)				61		79	139	125
BOOSTER PUMPS								
Pickups	7	29,200	2.00	58	0.75	22	80	73*
WATER RECIRCULATION								
Pickup (8 month operation)	1	4,200	2.00	8	0.75	3	11	10*

(cont'd.)

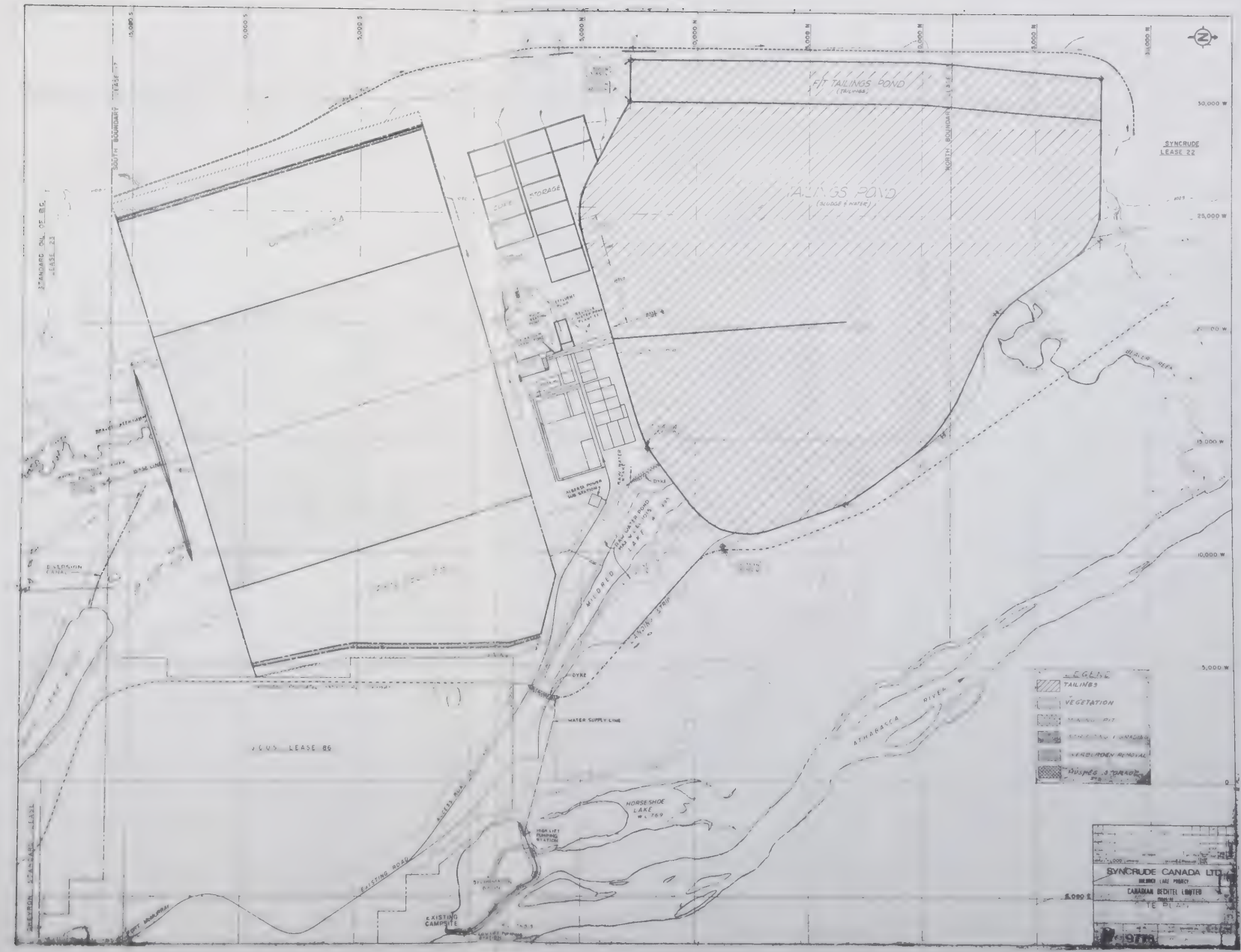
ANNUAL MOBILE EQUIPMENT SUPPLY COSTS

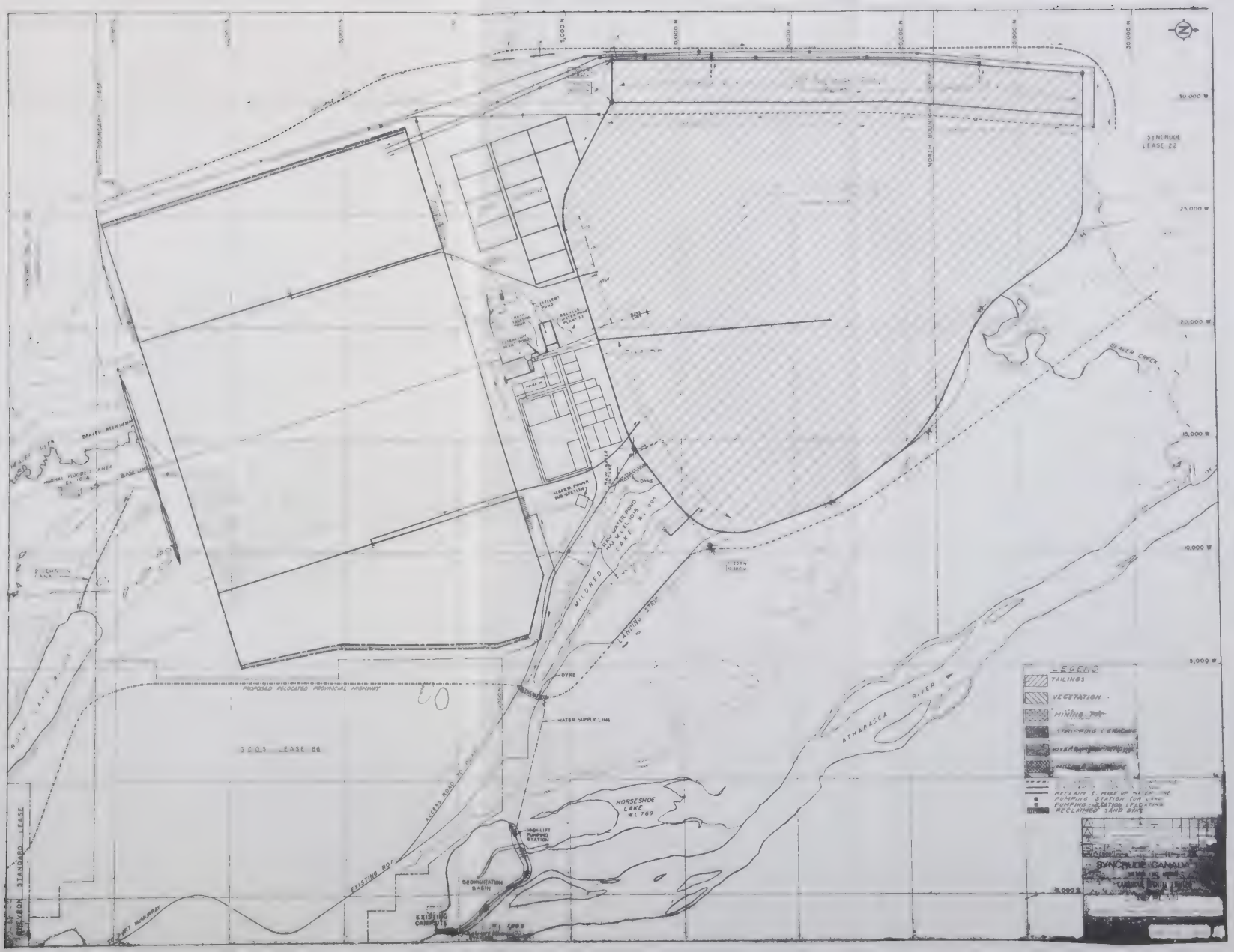
ITEM	No. of Units	Machine Hrs./Year	Oper. Supplies (Incl. Fuel) $/Hr.	Oper. Supplies (Incl. Fuel) $/Yr. (1000)	Maint. Supplies $/Hr.	Maint. Supplies $/Yr. (1000)	Total Supply $/Yr. (1000)	Gals. of Fuel (1000)
DIKE BUILDING								
Compactor 825	6	26,280	3.75	99	7.48	197	296	360
Dozer D/9	6	26,280	4.03	106	12.40	326	432	368
10T Trucks and Spreaders	6	8,760	3.15	28	1.50	13	41	39
Cement Compactors	3	4,380	3.75	16	7.48	33	49	60
Batch Plant	1	1,460	3.06	4	6.40	9	13	13
Cement	92 bags/hr. @ $2/bag			269			269	
(8 month operation) (1 & 3 shifts/day)				522		578	1,100	840
MISCELLANEOUS								
Dozer D/7	1	1,460	2.27	3	3.60	5	8	10
Motor Grader	1	1,460	4.54	7	2.66	4	11	12
Backhoe	1	1,460	4.62	7	6.71	10	17	19
F.E.L. 1/2 Cyd.	1	1,460	2.22	3	1.50	2	5	5
10T Trucks	2	2,920	3.15	9	1.50	4	13	13
Compactor	1	1,460	3.75	5	7.48	11	16	20
Low Boy	1	1,000	2.32	2	4.00	4	6	4
Pickup Trucks	4	16,000	2.00	32	0.75	12	44	40*
				68		52	120	123
		TOTAL		805		1,005	1,810	1,478
						DIESEL		1,355
						GAS		125

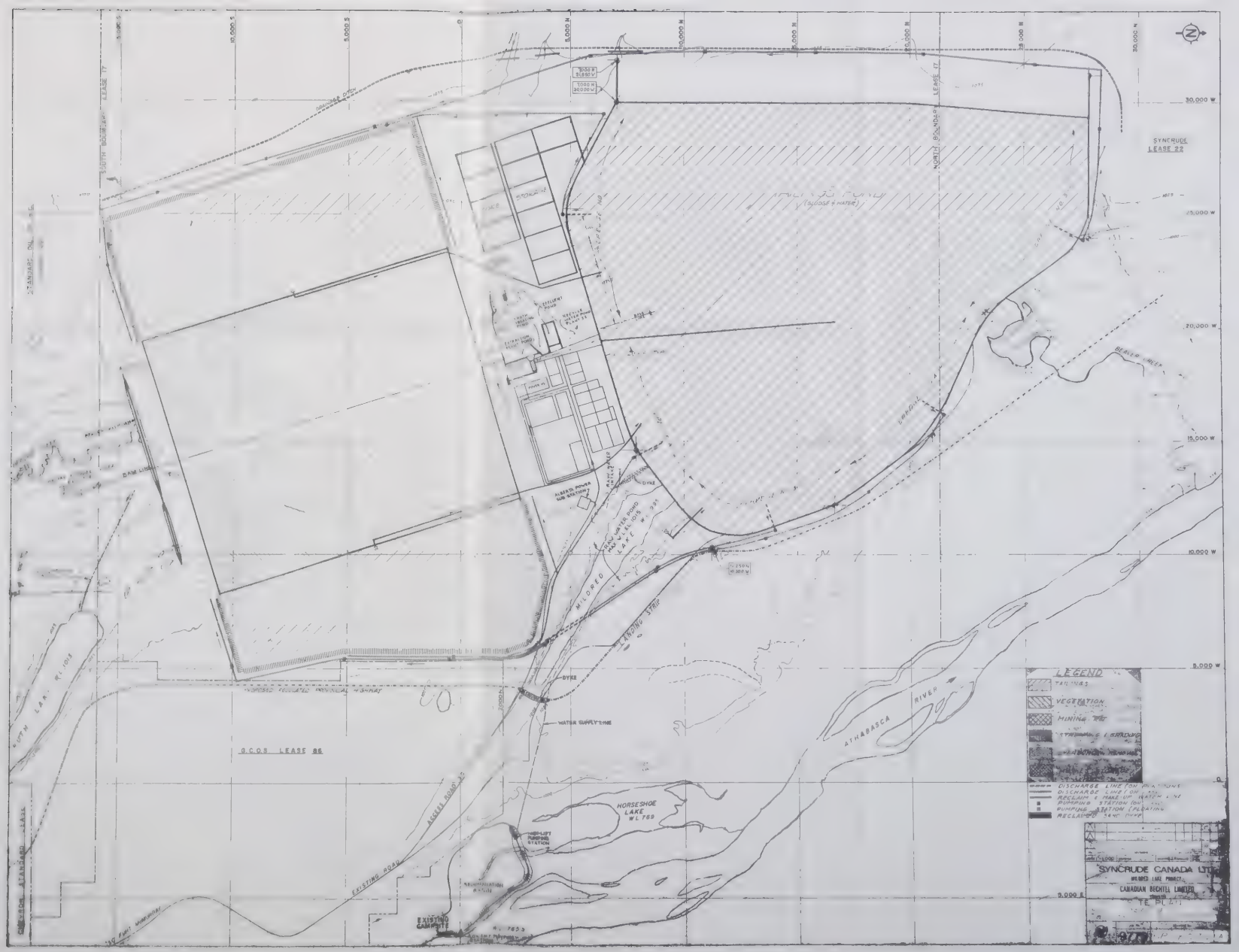
* Gasoline

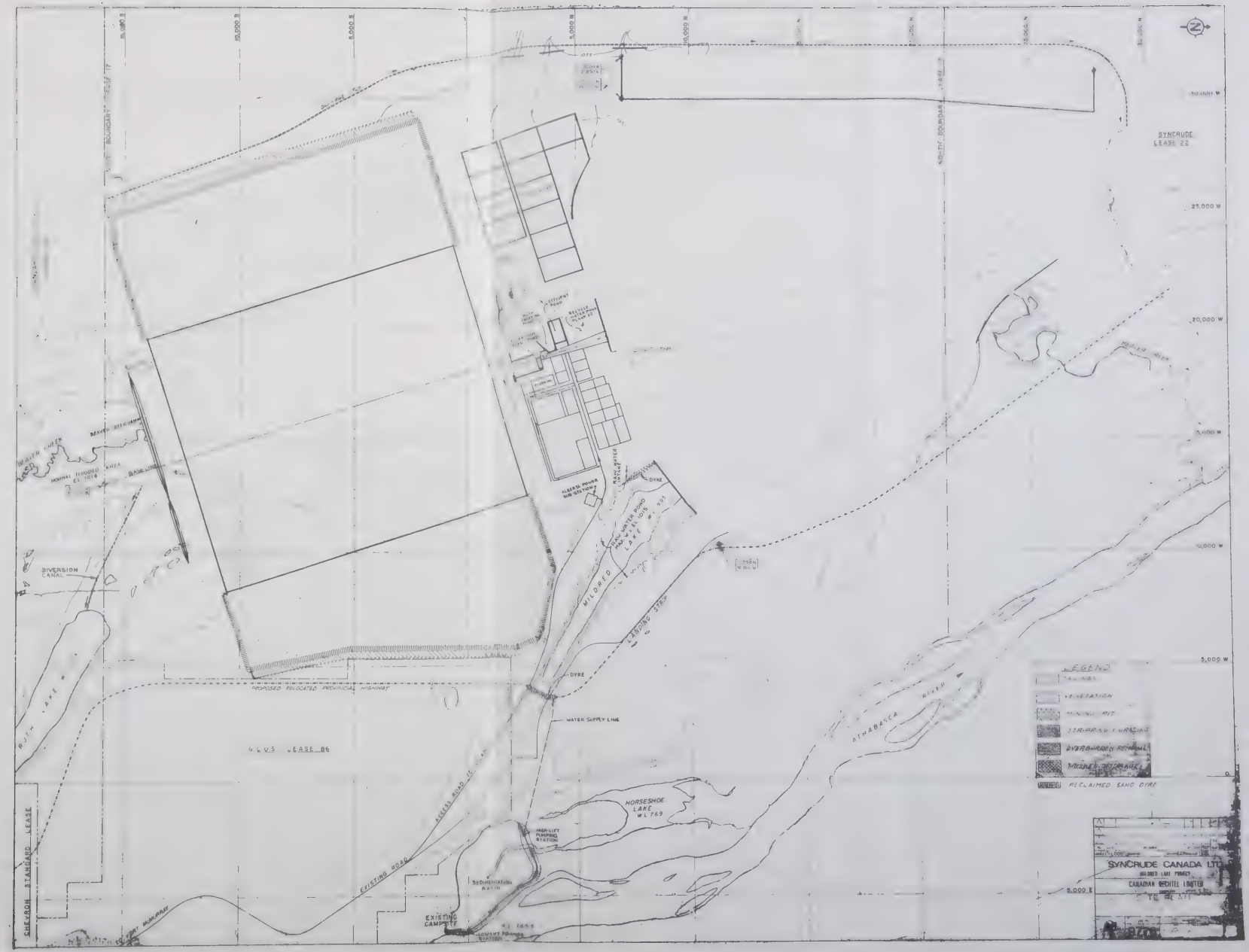
APPENDIX D - DRAWINGS

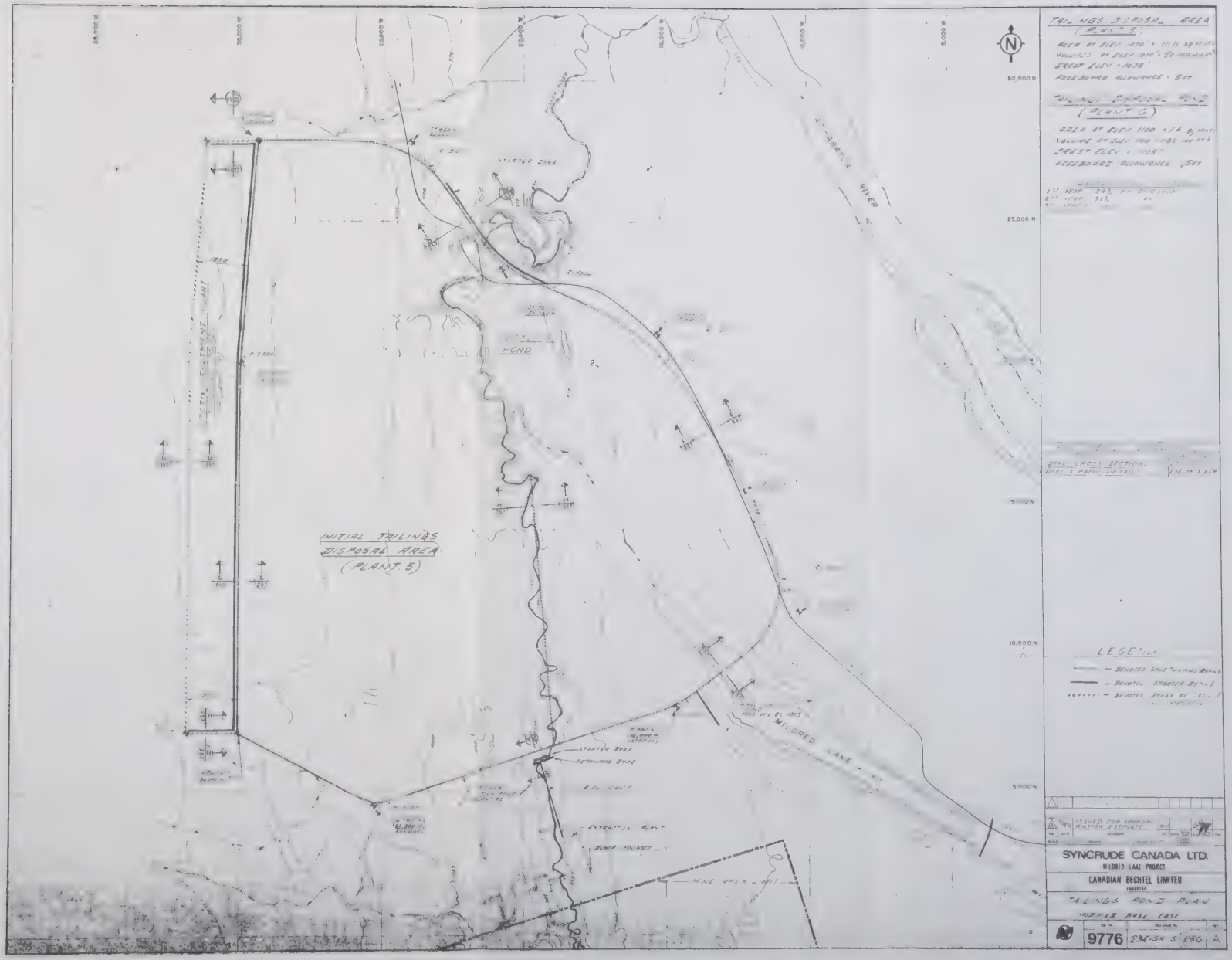
Drawing No.	Description	
51R-SK-S-767	Site Plan	Year 0
51R-SK-S-768	Site Plan	Year 1 Froth Treatment Pond Removal
51R-SK-5-769	Site Plan	Year 4 Main Tailings Pond Removal
51R-SK-S-770	Site Plan	Year 11
23E-SK-S-256	Tailings Pond	Plan
23E-SK-S-257	Tailings Pond	Dyke Cross Sections
51E-SK-S-771	Typical Section Thru Reclamation Pits	
51D-SK-S-772	General Arrangement Dredge Operation	

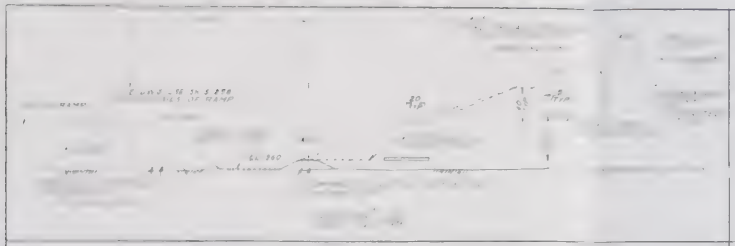

FIT TAILINGS POND
TAILINGS POND
(SLUDGE & WATER)
SYNCRUDE
LEASE 22
STANDARD OIL OF B.C.
LEASE 23
SOUTH BOUNDARY
NORTH BOUNDARY
STORAGE
DYKE
MILDRED
LAKE
ATHABASCA
RIVER
WATER SUPPLY LINE
HORSE SHOE
LAKE
W.L. 769
EXISTING
CAMPSITE
EXISTING ROAD
LEGEND
TAILINGS
VEGETATION
SYNCRUDE CANADA LTD.
CANADIAN BECHTEL LIMITED

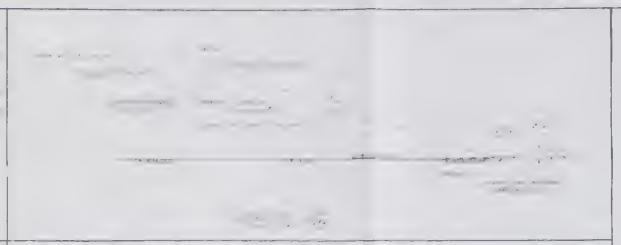

SYNCRUDE LEASE 22
NORTH BOUNDARY LEASE
SOUTH BOUNDARY LEASE
BEAVER CREEK
MILDRED LAKE
LEGEND
TAILINGS
VEGETATION
MINING
STRIPPING / LOADING
DYKE
RECLAIM & MAKE UP WATER PUMPING STATION
PUMPING STATION (FLOATING)
RECLAIMED SAND DYKE
PROPOSED RELOCATED PROVINCIAL HIGHWAY
DYKE
WATER SUPPLY LINE
S.C.O.S. LEASE 86
ACCESS ROAD TO
EXISTING RD
HORSESHOE LAKE
W.L. 769
HIGH LIFT PUMPING STATION
SEDIMENTATION BASIN
EXISTING CAMPSITE
ATHABASCA RIVER
SYNCRUDE CANADA

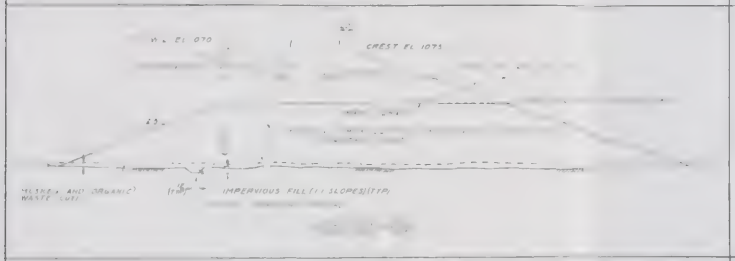

SYNCRUDE LEASE 22
SOUTH BOUNDARY LEASE 17
NORTH BOUNDARY LEASE 17
STANDARD OIL
SYNCRUDE CANADA LTD
MILDRED LAKE PROJECT
CANADIAN BECHTEL LIMITED
TE PLAN
LEGEND
TAILINGS
VEGETATION
MINING
DISCHARGE LINE FOR PLANT
DISCHARGE LINE FOR
RECLAIM & MAKE UP WATER LINE
PUMPING STATION FOR
PUMPING STATION (FLOATING
RECLAIMER
ATHABASCA RIVER
HORSESHOE LAKE
EXISTING CAMPSITE
EXISTING ROAD
ACCESS ROAD #3
WATER SUPPLY LINE
DYKE
LANDING STRIP
MILDRED
GCOS LEASE 86

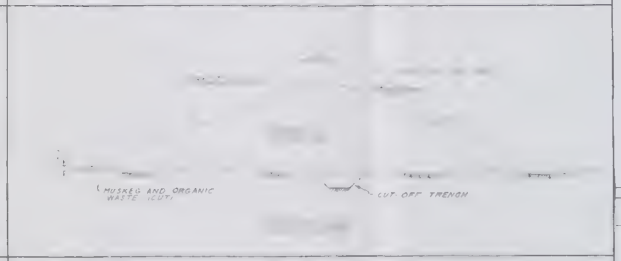

SYNCRUDE LEASE 22
DIVERSION CANAL
PROPOSED RELOCATED PROVINCIAL HIGHWAY
WATER SUPPLY LINE
ACCESS ROAD
EXISTING ROAD
EXISTING CAMPSITE
HORSESHOE LAKE WL 769
HIGH-LIFT PUMPING STATION
SEDIMENTATION BASIN
LOW-LIFT PUMPING STATION
ALBERTA POWER SUB STATION
DYKE
LANDING STRIP
MILDRED LAKE
ATHABASCA RIVER
GCOS LEASE 86
CHEVRON STANDARD LEASE
LEGEND
VEGETATION
MINING PIT
STRIPPING / MINING
OVERBURDEN REMOVAL
RECLAIMED SAND DYKE
SYNCRUDE CANADA LTD.
CANADIAN ARCHITEL LIMITED

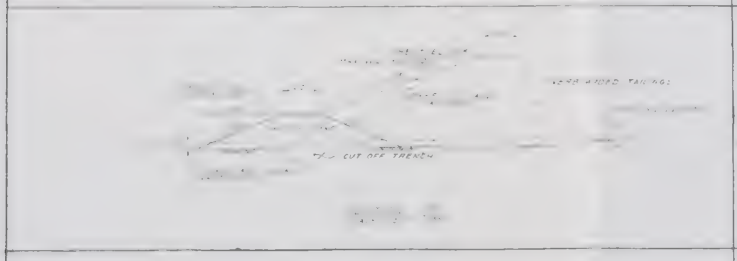

INITIAL TAILINGS DISPOSAL AREA (PLANT 5)
POND
MILDRED LAKE
SYNCRUDE CANADA LTD.
MILDRED LAKE PROJECT
CANADIAN BECHTEL LIMITED
TAILINGS POND PLAN
9776

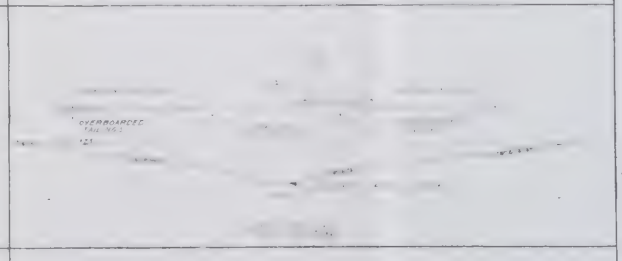


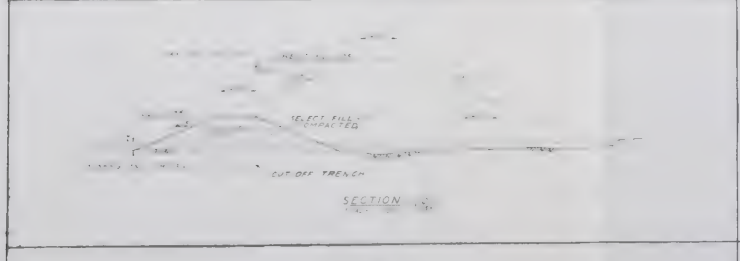


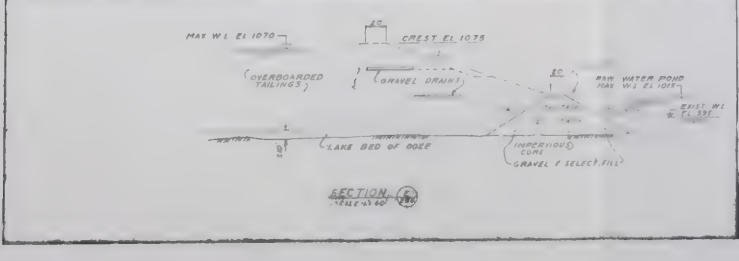












REFERENCE DRAWINGS

	03 POND PLAN	
	TYPE I RAMP DETAILS	

NOTES

1. SEE DWG 33F-1X1-858 FOR NOTES ON DIKE CONSTRUCTION USING SAND TAILINGS

A	13 MAY 80	ISSUED FOR APPROPRIATION ESTIMATE		
No.	DATE	REVISION	BY	CHKD

SYNCRUDE CANADA LTD.

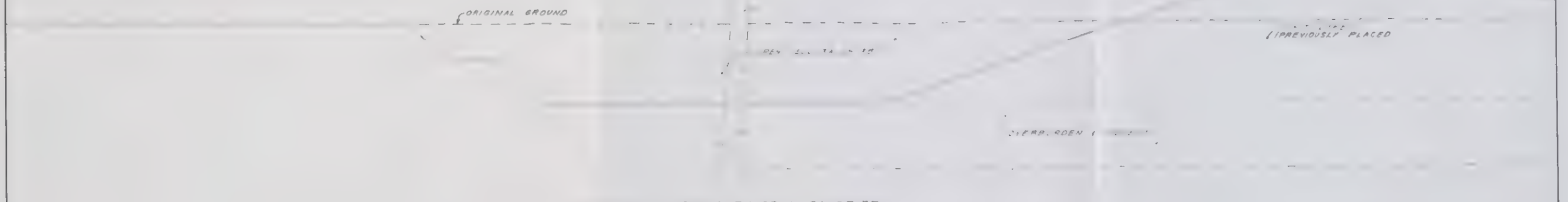
MILDRED LAKE PROJECT

CANADIAN DEWITEL LIMITED

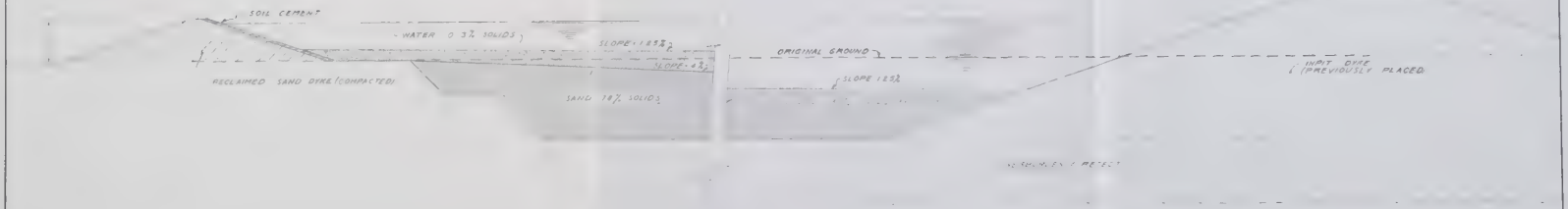
TAILINGS POND DIKE CROSS SECTIONS

MILDRED LAKE AREA

9776



TYPICAL SECTION THRU CELL 3A OR 3B
AFTER MINING PHASE



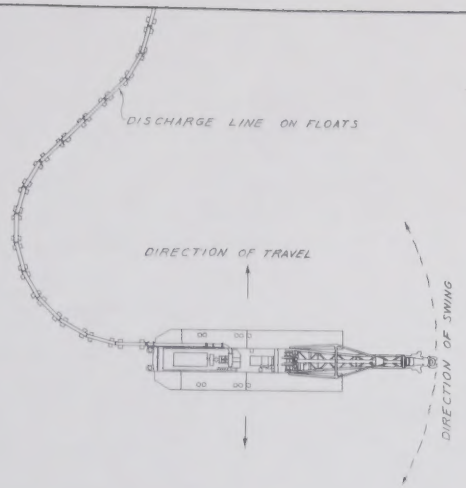
TYPICAL SECTION THRU CELL 3A OR 3B
AFTER TAILING RECLAMATION

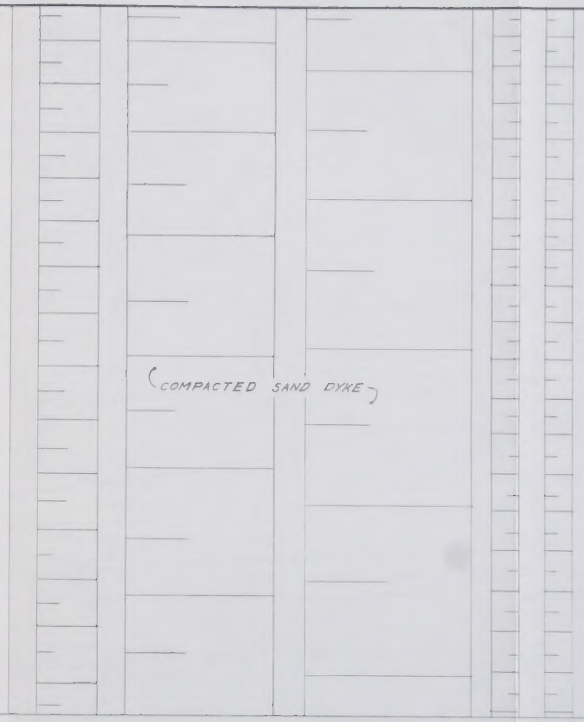
	ISSUED FOR INFORMATION	

SYNCRUDE CANADA LTD.
MILDRED LAKE PROJECT
CANADIAN BECHTEL LIMITED

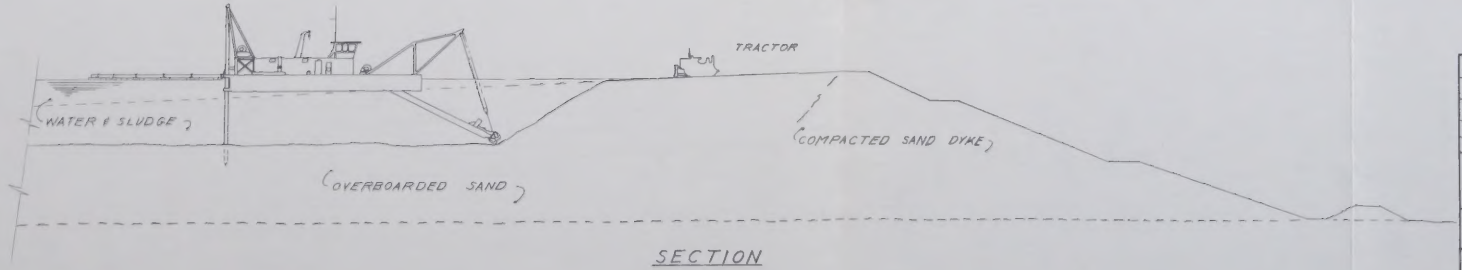
TYPICAL SECTION
THRU RECLAMATION PITS

JOB NO.	DRAWING NO.	REV
9776	51E-SK-S-771	A





PLAN



SECTION

No.	DATE	REVISIONS	BY	CHK	Owner Engr.	Eng'g	Proj. Eng'g.	Appr.
A	APR 19 1974	ISSUED FOR INFORMATION	W.M.			D.K.B.		

SCALE N.T.S | DESIGNED | DRAWN W.M. | CHIEF ENGR.

SYNCRUDE CANADA LTD.

MILDRED LAKE PROJECT

CANADIAN BECHTEL LIMITED

EDMONTON

GENERAL ARRANGEMENT
DREDGE OPERATION

JOB No.	DRAWING No.	REV.
9776	51D-SK-S-772	A